4.0 COMPARISON OF ALTERNATIVES

4.1 Comparison of Plan Features

All the action alternatives would require construction of new levees to protect adjacent properties from flooding. After site preparation, construction of levees, and placement of dredged material (if applicable), the levee between each cell and the bay would be graded down and breached, allowing tidal action on the site. Natural sedimentation, tidal action, and vegetation growth would then establish tidal salt marsh in each cell over a period of time.

Table 4-1 is a summary comparison of the activities proposed under each restoration alternative. Table 4-2 summarizes the total costs of the three alternatives. The differences consist chiefly of various features in the restoration plan for the BMK parcel; the only potential design changes within the boundary of the authorized Hamilton Wetland Restoration Project are:

1) elimination of the levee between the SLC and BMK parcels (all alternatives),
2) replacement of the levee between HAAF and BMK with an access berm (all alternatives),
3) increase and change of location of high transitional marsh on the SLC parcel (all alternatives),
4) rerouting of the NSD outfall pipeline due to an expanded Pacheco Pond (Alternatives 1 and 3),
5) repositioning of the SLC breach location (Alternatives 2 and 3), and
6) reduction in volume of dredged material placement on the SLC parcel (Alternative 3).

Alternatives 1 and 2 rely on placement of clean dredged materials as fill to establish a grade close to the final desired condition, with natural processes responsible for development to final conditions over time. Alternative 3 relies on natural depositional and erosional processes for all phases of restoration development, except for a small (90-acre) area in the southeastern portion of the site, where dredged materials would be placed. The principle differences between the three alternatives are related to:

1) logistical and time considerations associated with dredged material placement, including construction of infrastructure for delivery and placement of dredged materials (Alternatives 1 and 2),
2) time to establish desired habitat conditions (all three alternatives),
3) the acreage of seasonal wetlands, ranging from 0 to 210 acres (all three alternatives),
4) the length of levees to be constructed (all three alternatives), and
5) habitat diversity (all three alternatives).

Use of dredged materials under Alternatives 1 and 2 would require extension of the dredged material delivery infrastructure required for the authorized HWRP. The new infrastructure would consist chiefly of dredged sediment delivery pipelines, as the off-loading station, off-loader pipeline, off-loader, and associated pumps would already be constructed as part of the authorized HWRP.

In comparison to the natural sedimentation approach of Alternative 3, the use of dredged materials to establish initial surface elevations in Alternatives 1 and 2 would greatly decrease the amount of time required to establish tidal marsh vegetation and develop the desired habitat types by comparison with time to establishment. Dredged material placement would thus provide more habitat in a shorter amount of time for those species that use salt marsh and associated aquatic habitats, as well as seasonal wetlands, freshwater marshes, and upland transition habitats.

The required levee construction efforts for Alternatives 1 and 2 are considerably greater than Alternative 3 (97,000 linear feet for Alternative 1, 89,300 linear feet for Alternative 2 and 53,200 for Alternative 3, Table 4-1).

Use of natural sedimentation as the primary means of achieving marsh plain elevations precludes the development of seasonal wetlands under Alternative 3. Alternative 1 includes 40 acres of seasonal wetlands, and relies primarily on out-of-kind replacement of seasonal wetlands to achieve the no net loss of wetlands objective. Alternative 2 includes 210 acres of seasonal wetlands, achieving 100% in-kind replacement for existing seasonal wetland habitat, and a combination of seasonal and tidal wetland habitat replacement for the agricultural wetlands.

The three alternatives differ in final habitat distribution. Alternative 3 has the least diverse habitat, with the highest acreage of tidal marsh habitat (however, this habitat will require up to 50 years to become established). Alternative 1 provides an intermediate range of habitat types, and the least amount of tidal marsh. Approximately 19% of the habitat acreage created for the BMK parcel under Alternative 1 consists of upland/transition habitat. Alternative 2 has the most balanced mix of habitat types, and an intermediate acreage of tidal marsh.

The replacement, relocation and/or improvement of the NSD Outfall Pipeline and the associated Dechlorination Plant are authorized in the existing HWRP. However, in BMKV Alternatives 1 and 3 the proposed expansion of Pacheco pond will likely require changing the alignment of approximately 2,200 feet of the outfall pipeline. This will extend the outfall pipeline by approximately 500 lineal feet and have an additional cost of approximately $385,000. These actions are compatible with the currently selected alternatives of replacing the outfall pipeline with a new plastic (HDPE) pipeline within the existing easement and relocating the Dechlorination Plant to the NSD treatment plants.

Table 4-1
Summary Comparison of Features Associated with the Expansion Project Action Alternatives

Project Alternatives	Alternative 1 – Dredged Material Placement with Enlarged Pacheco Pond	Alternative 2 – Dredged Material Placement with Seasonal Wetlands	Alternative 3 – Natural Sedimentation with Enlarged Pacheco Pond
Earthwork			
New Levees	13,300 linear feet	15,200 linear feet	11,400 linear feet
Improved Levees/Berms	37,500 linear feet	35,700 linear feet	8,800 linear feet
Phase Containment Levees	30,400 linear feet	20,500 linear feet	6,500 linear feet
Internal Peninsulas/Berms	15,800 linear feet	17,900 linear feet	26,500 linear feet
Pilot Channel Excavation	2,100 linear feet	1,800 linear feet	1,200 linear feet
Dredged Material	13,200,000 cubic yards	13,000,000 cubic yards	0 cubic yards (a)
Habitat Acreage			
Upland Transition	300 acres	190 acres	55 acres
Open Water	40 acres	0 acres	40 acres
Freshwater Emergent Wetland	10 acres	N/A	10 acres
Seasonal Wetland	40 acres	210 acres	0 acres
High Transitional Marsh	160 acres	120 acres	30 acres
Tidal Marsh	849 acres	889 acres	1,204 acres
Low Marsh (b)	30 acres	30 acres	40 acres
Tidal Mudflat (c)	57 acres	52 acres	67 acres
Subtidal (d)	90 acres	85 acres	130 acres
Water Management			
Pacheco Pond: Change in Water Surface Elevation (10-year storm event)	–1.9 feet	–1.8 feet	–1.9 feet
Pacheco Pond: Change in Estimated Flood Storage Volume	+375 acre-feet	+259 acre-feet (in seasonal wetlands)	+375 acre-feet
Novato Creek: Change in Water Surface Elevation (10-year storm event)	No change	No change	No change
Novato Creek: Change in Invert Elevation Downstream of Breach	–0.5 feet	–0.5 feet	No change
Time to Establishment of Target Elevations			
Mud Flat	0 years	0 years	5 years
Low Marsh	0 years	0 years	15 years
Mid-High Marsh	10 years	10 years	40 years
Relocation of NSD facility	Minor modification to in-kind replacement of NSD outfall in accordance with WRDA '99 authorized project	In-kind replacement of NSD outfall in accordance with WRDA '99 authorized project	Minor modification to in-kind replacement of NSD outfall in accordance with WRDA '99 authorized project
Years to complete	12	12	5

(a) Represents fill associated with placement of dredged material on 90 acres of the southeast corner of the SLC parcel
(b) MSL–MHW
(c) MLLW–MSL (includes 2 acres of existing tidal mudflat on property)
(d) MLLW

Table 4-2
Summary of Costs
(2^{nd} Quarter 2001 Price Levels)

	No- Action	Alt 1	Alt 2	Alt 3
Lands and Damages	$0	$18,160,000	$18,135,000	$18,135,000
Relocations	$0	$385,000	$0	$385,000
Levees and Floodwalls	$0	$38,053,800	$36,023,300	$19,420,200
Adaptive Management	$0	$751,000	$710,500	$388,400
Dredged Material Placement	$0	$82,085,000	$80,841,400	$0
Recreation Features	$0	$1,365,000	$1,665,000	$1,665,000
Planning, Engineering & Design (PE&D)	$0	$2,000,000	$2,000,000	$2,000,000
E&D/Construction Management (S&A)	$0	$4,780,000	$4,780,000	$4,780,000
Total First Cost	$0	$147,579,900	$144,155,100	$47,373,000
Interest During Construction	$0	$18,614,900	$18,263,400	$6,469,800
Total Investment Cost	$0	$166,194,800	$162,418,500	$53,842,800
Average Annual Cost (@6.125 %)	$0	$8,514,700	$ 8,354,000	$ 6,469,800
Other OMRR &R Costs	$0	$296,400	$ 288,200	$178,500
Total Annual Cost	$0	$ 8,111,000	$ 8,642,200	$ 6,648,300

4.2 SYSTEM OF ACCOUNTS

4.2.1 Methodology

The Corps' Principles and Guidelines for the planning process have established four specific categories or "accounts" which are used to facilitate evaluation and display the effects of alternative plans. These accounts are: National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). These four accounts encompass all significant effects that a plan might have on the human environment as required by the National Environmental Policy Act of 1969 (NEPA) and encompass social well being as required by Section 122 of the Flood Control Act of 1970.

The NED account identifies beneficial and adverse effects on the nation's economy. Beneficial effects in the NED account are increases in the economic value of the national output of goods and services from a plan and are expressed in monetary units. For an ecosystem restoration project such as the expansion of HWRP to include BMK, the National Ecosystem Restoration (NER) account is used in place of the NED account. The Corps' objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to national ecosystem restoration (NER outputs) are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes. In this GRR, the outputs of proposed alternatives are ecosystem restoration, which are quantified in non-monetary units. Therefore, a NED plan is not identified in this study. ER-1105-2-100 states "Single purpose ecosystem restoration plans shall be formulated and evaluated in terms of their net contributions to increases in ecosystem value

(NER) outputs, expressed in non-monetary units…”. Each of these resource accounts and the results of the evaluation are described below.

Following the public review period, the non-Federal sponsor may choose to identify a locally preferred plan (LPP).

4.2.2 National Ecosystem Restoration (NER)

The NER plan is identified by the Federal government as the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective. It is cost-effective and justified to achieve the desired level of outputs. The NER plan is the restoration alternative that the Federal government will recommend in the Draft General Reevaluation Report, unless an exemption from the NER is required, as with a Locally Preferred Plan. The Federal government will cost share up to the price of the NER plan. For ecosystem restoration projects, the Federal share is 65%, while the non-Federal share is 35%. If beneficial reuse of dredged material is achieved, as in Alternatives 1 and 2, the Federal share increases to 75%, while the non-Federal share decreases to 25%. In accordance with the US Army Corps Policy Guidance Letter 59, the cost of approved recreation features will be cost shared at 50% Federal and 50% non-Federal, provided the Federal cost is not increased by more than 10%. The NER plan identified by this GRR is Alternative 2, Dredged Material Placement with Seasonal Wetlands. The rationale leading to this selection is described in the following sections and summarized in Section 4.6.

4.2.3 Environmental Quality (EQ)

Beneficial effects in the EQ account are favorable changes in the ecological, aesthetic, and cultural attributes of the natural and cultural environment. For the expansion of HWRP to include BMK, these include an increased value of wetland habitat and overall wildlife habitat. Adverse effects in the EQ account are unfavorable changes in the ecological, aesthetic, and cultural attributes of these same resources. As described in the Supplemental SEIS/R, there is a potential increase in methylmercury formation as a result of ecosystem restoration at the HWRP expansion to BMK.

Table 4-3
Summary of Environmental Quality Account

Environmental attributes	Alternatives			
	No Action	1	2	3
Ecological attributes (includes physical and biological aspects of ecosystems)				
Water quality	No impact	Potential increase in methylmercury formation	Potential increase in methylmercury formation	Potential increase in methylmercury formation
Air quality	No impact	Minor construction-related impacts	Minor construction-related impacts	Minor construction-related impacts
Overall wildlife Habitat value	No impact	Significant positive effect	Significant positive effect	Significant positive effect
Tidal wetland Habitat value	No impact	Large positive effect	Large positive effect	Large positive effect
Seasonal Wetland habitat Value	No impact	Minor negative effect	Moderate positive effect	Moderate negative effect
Upland habitat Value	No impact	Moderate loss	Moderate loss	Large loss
Cultural environment				
Cultural Resources	No impact	Potential disturbance of unknown sites	Potential disturbance of unknown sites	Potential disturbance of unknown sites
Aesthetic environment				
Noise	No impact	Minor construction-related impacts	Minor construction-related impacts	Minor construction-related impacts
Visual Resources	No impact	Minor temporary impacts; long-term change in views from BMK community	Minor temporary impacts; long-term change in views from BMK community	Minor temporary impacts; long-term change in views from BMK community

4.2.4 Other Social Effects (OSE)

Other social effects involve urban and community impacts such as employment distribution, potential displacement of businesses, and local government's fiscal condition, as well as life, health, and safety effects. For the Hamilton Wetland Restoration Project proposed expansion to include Bel Marin Keys, these impacts are not directly measurable; however, the restoration of wetlands will improve the quality of community life for residents near the restored site and regionally by increasing the value of wildlife habitat and increasing recreational access to the Bay Trail. There is a minor potential increase to offsite fishing and hunting as the value of wildlife habitat is increased.

4.2.5 Regional Economic Development (RED)

The Regional Economic Development (RED) account is intended to illustrate the effects that the study alternatives would have on regional economic activity; specifically, regional income and regional employment. The comparison of possible effects that the plans would have on these resources is shown in Table 4-4.

Table 4-4
Other Social Effects and Regional Economic Development Accounts

I. Regional Economic Development	**No Action**	**Alternative 1**	**Alternative 2**	**Alternative 3**
Employment/Labor Force	No change expected	12 year temporary increase in construction-related employment	12 year temporary increase in construction related employment	5 year temporary increase in construction-related employment
Business and Industrial Activity	N/A	*Potential increase in shipping efficiencies given the lack of dredging delays	*Potential increase in shipping efficiencies given the lack of dredging delays	N/A
Local Government Finance-State of California (Total Project First Cost)	N/A	Restoration $36,558,000 Recreation $1,120,000 Total $37,678,000	Restoration $35,200,000 Recreation $1,300,000 Total $36,500,000	Restoration $11,577,000 Recreation $958,000 Total $12,535,000
II. Other Social Effects				
Public Health and Safety	N/A	Improved well being due to enhanced habitat	Improved well being due to enhanced habitat	Improved well being due to enhanced habitat
Public Facilities and Services	N/A	N/A	N/A	N/A
Recreation and Public Access	No change expected	Increased recreational opportunities from enhanced habitat	Increased recreational opportunities from enhanced habitat	Increased recreational opportunities from enhanced habitat
Traffic/Transportation	No change expected	No change expected	No change expected	No change expected
Man Made Resources	N/A	N/A	N/A	N/A
Natural Resources	No change anticipated	Increased special-status species habitat; Restoration of healthy, diverse wetlands; Potential minor increase in offsite fishing and hunting.	Increased special-status species habitat; Restoration of healthy, diverse wetlands; Potential minor increase in offsite fishing and hunting.	Increased special-status species habitat; Restoration of healthy, diverse wetlands; Potential minor increase in offsite fishing and hunting.

*Note: The potential increase in shipping efficiencies will have more of a national than regional effect, which would normally be included in the NED account. However, as the NED account is not used in ecosystem restoration, this effect was included in the RED account.

4.3 INCREMENTAL ANALYSIS OF PROJECT FEATURES

4.3.1 Purpose of the Incremental Analysis

This general reevaluation study examines the alternatives using a number of analyses and evaluation criteria. While there is no generally accepted method for quantifying environmental benefits in monetary terms, two decision-making tools have helped planners decide how to allocate limited resources more effectively. *Cost effectiveness* analysis helps filter out plans with equivalent output levels that are more expensive. *Incremental analysis* allows planners to progressively proceed through available levels of output and asks if the next level of additional outputs is worth its additional cost. Another analysis that must be performed is an examination of the incremental cost-efficiency of different potential measures to create fish and wildlife habitat value. This analysis is normally performed on measures that mitigate the impacts of a project on fish and wildlife habitat. In an environmental restoration study, the incremental cost analysis instead examines the cost-efficiency of the environmental restoration alternatives themselves.

In an incremental analysis, each possible combination of increments is examined for cost-efficiency. As cost-efficiency in producing fish and wildlife habitat value is only one of the criteria used to evaluate alternatives, the conclusions of this analysis are not the sole determinant of which alternatives receive detailed consideration in the feasibility study, nor which alternative is selected as the preferred plan.

The study alternatives can be broken down into two basic choices. The first choice is whether to use dredged material to accelerate the process of marsh formation. The second is whether to expand Pacheco Pond or restore it to seasonal wetland. This section analyzes the cost-efficiency of these alternatives in achieving the planning objective of tidal marsh restoration. Some of these alternatives are not responsive to other planning objectives, but are included here for purposes of comparison.

4.3.2 Use of the Habitat Evaluation Procedure Results

A Habitat Evaluation Procedure (HEP) study to determine HWRP impacts on wildlife habitat was performed by the U.S. Fish and Wildlife Service (FWS). This study looked at impacts on all habitats that either currently exist or would be created under the alternatives. In a HEP study, individual wildlife species serve as surrogates for entire habitats, with impacts on these *evaluation species* used to indicate impacts on the habitats they inhabit.

A HEP study normally fulfills two functions in a Corps flood damage reduction or navigation feasibility study where existing habitat must be protected. First, it determines impacts on various existing wildlife habitats to determine mitigation requirements. Second, it is used by the Corps to determine the cost-effectiveness and efficiency of different mitigation increments. The incremental analysis for mitigation included in a feasibility report or general reevaluation report compares the cost and output of each mitigation increment to determine the optimal level of investment in mitigation. However, this approach has difficulties when applied to an ecological restoration study such as this one, as HEP does not differentiate between Habitat Units (HUs) of a common species and HUs of a rare species, nor between the value of common and scarce habitats. Nor does it consider the ecological role of a species or habitat outside of the project site itself, that is, in the local or regional context.

In an ecosystem restoration project, the objective is to improve and create habitat; as a result, mitigation should not be required and the mitigation-oriented HEP is instead used to determine the output of each alternative. In the case of the Hamilton wetland restoration study, the FWS HEP showed relatively small overall gains in HUs from using dredged material to accelerate the rate of marsh formation. This is because as tidal marsh develops, it replaces mudflats which themselves have habitat value. Accelerating the rate of tidal marsh development merely accelerates the rate at which this tradeoff occurs, yielding little increase in total habitat units.

For this reason, the standard incremental mitigation analysis for this study has been modified to instead measure the cost-effectiveness and cost-efficiency of project increments in creating tidal salt marsh and other wetlands. Tidal marsh habitat is of particular concern in the San Francisco Estuary (San Francisco, San Pablo, and Suisun Bays) due to the magnitude of historic losses of this habitat type, the high ecological value of this habitat, and its particular importance to endangered species (the California clapper rail and the salt marsh harvest mouse). The non-tidal wetlands evaluated in the HEP also have high ecological importance, have suffered major losses in the region and are a priority for restoration efforts.

To evaluate the habitat benefits of using dredged material, the 12 evaluation species/habitat combinations used in the FWS HEP for the HWRP were narrowed down to 5 combinations: salt marsh rail guild/tidal salt marsh; egret guild/tidal salt marsh; wintering mallard/seasonal wetland; desert cottontail/seasonal wetland; and wintering mallard/non-tidal emergent marsh. These are the species/habitat combinations within the HEP that would particularly benefit from wetland restoration. Limiting the analysis to these combinations allows the cost-effectiveness and cost-efficiency of the alternatives in creating wetland habitats to be determined.

The exclusion of the other species/habitat combinations was made knowing that some of them would experience net losses. However, trading off these species and their habitats for species and habitats deemed much more important has been endorsed (within certain limits) by the non-federal sponsor and the resource agencies, and in fact is an unavoidable consequence of implementing any of the action alternatives.

Existing and future wetland habitats on the BMK parcel were assigned habitat values (habitat suitability indices) based upon the results of the HWRP HEP, with adjustments to reflect differences in habitat evolution. Cumulative and average annual habitat units were then calculated based upon these habitat suitability indices, habitat acreages, and construction phasing.

4.3.3 Cost Effectiveness/Incremental Cost Analysis

4.3.3.1 Introduction

When a common measurement unit for comparing non-monetary project benefits with monetary project costs does not exist, a traditional benefit-cost analysis cannot be performed to evaluate the project alternatives and identify the most “optimal” plan – the plan that maximizes net benefits. For the proposed expansion of HWRP to include BMK, where project costs were measured in dollars and project benefits were measured in habitat units, cost effectiveness and incremental cost analyses (CEA/ICA) were used as an alternative approach to evaluate plans.

Cost effectiveness analysis and incremental cost analysis are valuable planning tools that assist in the decision making process. For Bel Marin, CEA/ICA allowed for the examination of environmental outputs, the elimination of an economically irrational plan, and the comparison of the relative cost effectiveness of the remaining plans. The analysis and the results are explained below.

4.3.3.2 Key Assumptions and Data Input

· Project outputs are expressed as average annual habitat units (AAHU), which represent the average annual habitat units of wetlands (tidal and non-tidal marsh) produced by a plan.
· Project costs include first costs, adaptive management costs, and interest during construction.
· Construction costs for ICA purposes for Alternative 1 (BMK1), Alternative 2 (BMK2), and Alternative 3 (BMK3) are $113,274,000, $111,135,200 and $39,369,800, respectively.
· The construction period for Alternatives 1 and 2 is 12 years, but benefits begin to accrue at 5 years. The construction period of Alternative 3 is 5 years.
· The study life is 50 years; the discount rate is 6.125 percent.
· Average annual costs for alternative one (BMK1), alternative two (BMK2), and alternative three (BMK3) are $8,514,745, $8,353,972, and $2,959,406, respectively.
· Average annual habitat units for Alternative 1, Alternative 2, and Alternative 3 are 365, 457, and 214, respectively.

4.3.3.3 Step 1 – Eliminating Non-Cost Effective Plans

For the proposed expansion of HWRP to include BMK, the alternatives were first ordered by increasing costs. Alternative 3 (BMK3) has the lowest average annual costs at $2,744,061, followed by Alternative 2 (BMK2, $6,756,689) and Alternative 1 (BMK1, $6,959,820). The "no action" plan, of course, has zero costs. Table 4-6 displays the plans and their respective costs.

Table 4-5
Array of Alternatives Sorted by Increasing Costs

Bel Marin Keys Alternative	**Average Annual Cost ($)**
No Action Plan	$0
BMK3 (Natural Sedimentation with Enlarged Pacheco Pond)	$2,959,406
BMK2 (Dredged Material Placement with Seasonal Wetlands)	$8,353,972
BMK1 (Dredged Material Placement with Enlarged Pacheco Pond)	$8,514,745

From the array of alternatives, all of the the non-cost effective plans were eliminated. A plan is considered to be non-cost effective if there exists another plan that either 1) produces the same level of output at less cost, 2) produces a greater level of output at the same cost, or 3) produces a greater level of output at less cost. As Table 4-7 shows, Alternative 1 is considered a non-cost effective plan (and is identified by a slash through its row) because both Alternative 2 and

Alternative 3 produce a greater level of output at less cost. The Alternative 1 plan is thus eliminated from further analysis.

Table 4-6
1st Iteration – Eliminating the Non-Cost Effective Plan(s)

	Average Annual Cost ($)	Output (Average Annual Habitat Units)
No Action Plan	$0	0
Alternative 3	$2,959,406	214
Alternative 2	$8,353,972	457
~~Alternative 1~~	~~$8,514,745~~	~~365~~

<u>4.3.3.4 Step 2 – Identifying the "Best Buys" or Least Incremental Cost Alternatives</u>

Once all of the non-cost effective plans were identified and eliminated, the CEA/ICA proceeded by treating the No Action plan as the first increment (or baseline) and then using this baseline to calculate incremental costs, incremental outputs and incremental cost per unit of output for each of the remaining two alternatives. Next, the plan that is the "best buy" was then identified; this is the plan that has the lowest incremental cost per unit of output and which is the most cost efficient (i.e., it offers the "biggest bang per buck"). As Table 4-8 reveals, Alternative 3 is the most cost efficient of the remaining alternatives, having an incremental cost of $13,829 per unit of output (compared to a cost of $18,280 per unit of output for Alternative 2).

While Alternative 2 is still cost effective, Alternative 3 is the best buy and is the next best alternative that can be chosen above the No Action plan. This Alternative 3 plan, then, serves as the baseline for the next step.

Table 4-7
2nd Iteration – Identifying the Best Buy Plan

Alternative	Average Annual Cost ($)	Output (Average Annual Habitat Units)	Incremental Cost ($)	Incremental Output (Average Annual Habitat Units)	Incremental Cost Per Unit of Output ($/AAHU)
No Action Plan (baseline)	$0	0	---	---	---
Alternative 3	$2,959,406	214	$2,959,406	214	$13,829
Alternative 2	$8,353,972	457	$8,353,972	457	$18,280

<u>4.3.3.5 Step 3 – Recalculating Incremental Costs, Incremental Outputs, and Incremental Costs Per Unit of Output Using the Alternative 3 Plan as the Baseline</u>

Incremental costs, incremental outputs, and incremental cost per unit of output were then recalculated for Alternative 2 using the "best buy" alternative (Alternative 3) as the baseline. As Table 4-9 shows, for Alternative 2, the incremental cost is $5,576,566, the incremental output is 243, and the incremental cost per unit of output is $22,949. In other words, each of the additional

1.165 average annual habitat units gained over that of the Alternative 3 alternative costs approximately $22,949.

Table 4-8
3rd Iteration – Recalculate Incremental Costs, Incremental Outputs, and Incremental Costs Per Unit of Output Using the BMK3 Plan as the Baseline

Alternative	Average Annual Cost ($)	Output (Average Annual Habitat Units)	Incremental Cost ($)	Incremental Output (Average Annual Habitat Units)	Incremental Cost Per Unit of Output ($/AAHU)
No Action Plan	$0	0	---	---	---
Alternative 3 (baseline)	$2,959,406	214	$2,959,406	214	$13,829
Alternative 2	$8,535,972	457	$5,576,566	243	$22,949

4.3.3.6 Conclusion and the Final Array of Alternatives

Table 4-10 displays the final array of alternatives for the Bel Marin Keys Restoration Project along with their respective cost and output information.

Table 4-9
Final Array of Alternatives

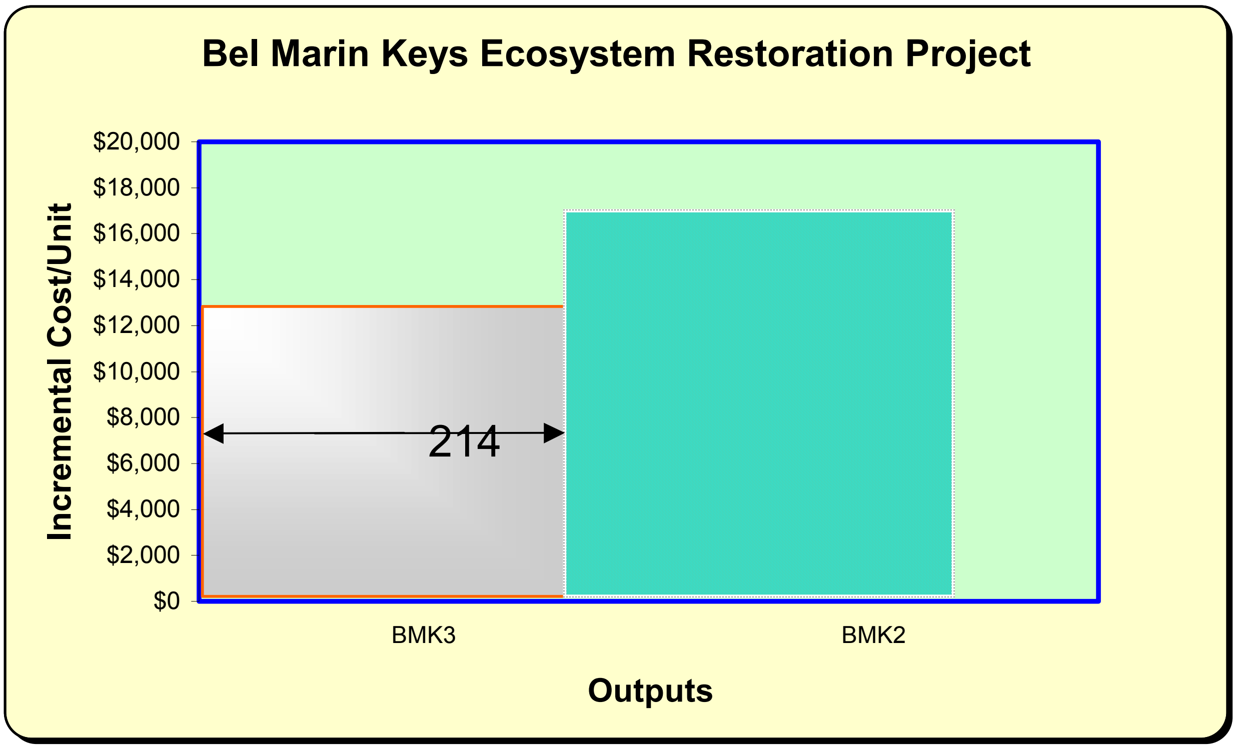
Bel Marin Keys Plan	Average Annual Cost ($)	Output (Average Annual Habitat Units)	Incremental Cost ($)	Incremental Output (Average Annual Habitat Units)	Incremental Cost Per Unit of Output ($/AAHU)
No Action Plan	$0	0	---	---	---
Alternative 3	$2,959,406	214	$2,959,406	214	$13,829
Alternative 2	$8,535,972	457	$5,576,566	243	$22,949

Cost effectiveness and incremental cost analyses are valuable planning tools to assist in the decision-making process. However, unlike in a traditional benefit-cost analysis, in which a unique plan can be identified as the National Economic Development (NED) plan, CEA-ICA will not identify a unique solution for plan selection (the National Ecosystem Restoration or NER Plan).

In the case of the Bel Marin Keys Restoration Project, Alternative 3 is the best buy. It is this plan that offers the "biggest bang per buck." Alternative 2, however, does provide for an additional 243 average annual habitat units, but at a significant incremental cost per unit ($22,949). When an alternative's incremental cost per unit of output increases relatively sharply in contrast to the incremental cost per unit of output for the alternative preceding (as in this case) or following it, a "breakpoint" is revealed in the incremental cost curve. This spike in the incremental cost curve can serve as a potential decision point by focusing on the question, "Is it worth it?" and by providing decision makers with reasons to question the "worth" of the additional incremental cost.

If it is decided that the approximately 214 habitat units are worth $13,829 each, then it must be decided if the additional 243 habitat units are worth $22,949 each. Deciding whether or not an additional environmental benefit of one plan over another is worth its additional costs requires that "decision makers base subjective judgments about the value of the output being produced on additional information generated outside the framework of CEA/ICA" (IWR Report #95-R-1).

Figure 4-1



4.3.4 Relationship of the Incremental Analysis Conclusions to the Study Alternatives

The incremental analysis determined that Alternatives 2 and 3 are most cost-efficient for their level of output of tidal marsh habitat. Alternative 1 was determined not to be cost-efficient for this output. However, other criteria are used in evaluating and screening potential alternatives and are applied here to the alternatives considered.

4.4 ASSOCIATED EVALUATION CRITERIA

The alternative plans were evaluated against the specific criteria (completeness, effectiveness, efficiency, and acceptability) presented in US Army Corps of Engineers Regulation ER 1105-2-100. The four criteria described below are used to evaluate project plans under Federal guidelines. These criteria are also used to narrow the alternatives to a recommended plan.

4.4.1 Completeness

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure realization of the planned effects. This criterion assures that all measures required to achieve the desired outputs are included in the plan, or at least addressed.

All the action alternatives are complete conceptual tidal marsh restoration plans. None of these alternatives require any additional substantial features to accomplish the study objectives. The No Action Plan is not complete because it does not address the identified problems and opportunities

4.4.2 Effectiveness

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. Effectiveness is a measure of a plan's ability to achieve the desired output and can be evaluated as follows:

- Plans must represent sound, safe acceptable engineering solutions to the problems and needs.
- Plans must be technically achievable and cannot contain obstructions that would prevent accomplishment of the desired output.
- Plans must be realistic and state-of-the-art. However, they must not rely on future research and development of key components.

Habitat Restoration

Wetland and endangered species habitat: All the action alternatives are effective to varying degrees in restoring wetland habitat and its value for endangered species. Alternative 2 is the most effective, as it restores more of this habitat than Alternative 1, and restores this habitat in less time than Alternative 3. Alternative 2 also provides the greatest diversity of habitat. Ecosystems are most healthy and sustainable, and most valuable to animals when they contain a range of habitat types covering a range of elevations. An important component of tidal marsh habitat is the presence of higher elevation areas for animals such as the harvest mouse to retreat to during high tide events. Alternative 3 does not allow for the creation of seasonal wetlands and limits the amount of upland habitat and high tide refugia that can be created. Considering the diversity of habitat, Alternative 2 adds value that is not provided by either Alternative 1 or 3. The no-action alternative is not effective in increasing these habitats.

Beneficial Reuse of Dredged Material

As described in this document, the Long-Term Management Strategy for dredged material in the San Francisco Bay Area, which is part of Corps Policy for the Bay Area, has a goal of 40% upland reuse of dredged sediment. The beneficial reuse of dredged sediment at BMK would substantially increase the capacity for upland reuse, and would assure the availability of upland reuse opportunities into the future. It would thus support the long-term success of the LTMS. It is important to recognize that these benefits can be achieved with fewer environmental impacts because the off-loader facilities (including the off-loading station and off-loader pipeline and pumps) will already have been constructed for the authorized project. Allowing beneficial reuse at the BMK parcel would lead to extended use of facilities that would already be constructed. Thus, Alternatives 1 and 2 rate more favorably than Alternative 3, with Alternative 1 being slightly more effective because it provides slightly more upland disposal capacity. The no-action alternative and Alternative 3 are not effective in furthering this objective because they do not provide for upland disposal of dredged material.

Overall Effectiveness
Alternative 2 is most effective overall in achieving the study objectives of wetland restoration (including endangered species habitat restoration), and beneficial reuse of dredged material.

4.4.3 Efficiency

Efficiency can be examined in several different ways for this project. Economic efficiency measures the amount of project outputs (such as habitat units, acres of tidal marsh, or upland dredged material disposal capacity) per unit of economic cost. Ecological efficiency measures the amount of project output per unit of ecological input.

Economic Efficiency
As explained above in the incremental analysis, the most economically efficient study alternative in terms of creation of habitat units is Alternative 3, with an incremental cost of $13,829 per habitat unit over the No-Action Plan. Alternative 2 has a higher incremental cost, but is cost-efficient for its level of output and has an average cost per habitat unit of $18,280. Alternative 1 is not cost-efficient for its level of habitat output with a cost per habitat unit of $23,328.

Alternative 1 has a total first cost of $147,579,900 and a dredged material placement capacity of 13.2 mcy ($11.18/cy) while Alternative 2 has a total first cost of $144,155,100 and dredged material placement capacity of 13.0 mcy ($11.09/cy). Alternatives 3 and the no-action alternative do not provide dredged material disposal capacity. Alternative 2 is therefore the most efficient at meeting the objective of providing capacity for upland disposal of dredged material, as stated in the LTMS program and other plans, as it provides the lowest unit cost for upland disposal.

Alternative 1 is not cost-efficient for its level of *habitat* output; however, this alternative provides for the upland disposal of dredged material in a cost-efficient manner. The cost-efficient disposal of dredged material created by using dredged material in this alternative can be viewed as a free benefit of accelerated wetland restoration. Therefore, considering both tidal marsh habitat creation and dredged material reuse, Alternatives 1 can be considered to be quite economically efficient.

Ecological Efficiency
Ecological efficiency is harder to quantify. One way to measure it is to measure the amount of desired habitat value created per acre of habitat created. Since tidal and seasonal wetlands are the primary habitat objective of this project, Table 4.10 shows the output of tidal marsh habitat units per acre of tidal marsh created. This table shows that alternatives using dredged material produce more habitat value (over the 50-year evaluation period) per acre of wetland ultimately

created. This result is expected since the HEP assumes that tidal marsh would form faster with the use of dredged material.

All the action alternatives would increase the total amount of habitat on the site by converting current agricultural lands to wildlife habitat. These alternatives would also replace common grassland habitat with scarce tidal marsh habitat, while retaining existing non-tidal wetland habitat values (except Alternative 3) and enhancing endangered species habitat values. In this sense, all the alternatives are ecologically efficient, especially Alternatives 1 and 2 as they produce these results to a greater degree.

Table 4-10
Comparative Ecological Efficiency Of the Study Alternatives

Alternative	*Average Annual Habitat Units*	*Total Acres of Wetland Created*	*Wetland Habitat Value Gain Per Acre*
1	365	1089	0.34
2	457	1249	0.37
3	214	1284	0.17

The no-action alternative maintains existing habitats on the BMK parcel, but fails to restore valuable habitats that have suffered severe historic losses and which provide endangered species habitat. As this alternative would create neither ecological losses nor ecological gains, it can not be considered to be ecologically efficient or inefficient. Nonetheless, it represents a lost opportunity for improving environmental quality.

Overall Efficiency
In terms of average costs, Alternative 3 is most cost-efficient at producing wetland habitat on the BMK site, with Alternative 2 being efficient for its level of output. Alternatives 1 and 2 have similar cost-efficiencies for dredged material disposal. While Alternative 1 is less efficient (in terms of marginal economic costs) in producing wetland habitat than Alternatives 2 and 3, the combined efficiency in producing upland disposal of dredged material and tidal marsh habitat is high.

4.4.4 Acceptability

Acceptability is the workability and viability of the alternative plans with respect to acceptance by state and local entities, as well as the public, and compatibility with existing laws, regulations, and public policies. The No Action Plan is not acceptable to any federal or state agency involved in the project. Alternatives 1 and 2 are acceptable to the non-federal sponsor, local agencies, and the resources agencies, provided that concerns over such issues as drainage, flood control, and levee stability are adequately addressed. Table 4.11 shows the responsiveness of the alternatives to various local, regional, and federal plans. Alternative 2 is the most responsive to these plans because it provides the maximum wetland habitat value and the most efficient beneficial reuse of dredged material.

Table 4-11
Responsiveness of the Expansion Alternatives to
Local, Regional and Federal Plans

	Alternatives		
Plan/Agency	***1***	***2***	***3***
San Francisco Bay Plan / S.F. Bay Conservation and Development Commission	H	H	L
General Plan / City of Novato	H	H	M
Draft S.F. Estuary Ecosystem Goals Report / Interagency Project	H	H	M
S.F. Estuary Comprehensive Conservation and Management Plan / S.F. Estuary Project	H	H	M
Long-Term Management Strategy / Interagency Program	H	H	L
Ecosystem Restoration Program Plan / CALFED	H	H	M
Oakland Harbor Navigation Improvement / Corps of Engineers and Port of Oakland	H	H	L

L = low M = medium H = high

4.5 Tradeoff Analysis

4.5.1 Display of Relative Rankings

The three alternatives were assigned relative rankings indicating how well they would address the study objectives and selected evaluation criteria. A ranking of 1 indicates that the alternative best satisfies that objective or criterion. Economic efficiency ratings were determined using average rather than marginal economic costs. Ecological efficiency was not included due to important qualitative considerations. The rankings are displayed in Table 4.13. Note that in some cases alternatives were tied in their rankings.

4.5.2 Tradeoffs between Alternatives

Wetland
As discussed in Section 4.4.2, all of the action alternatives are effective in restoring wetland habitat. Alternative 2 is the most effective, as it restores a greater quantity of this habitat than Alternative 1, and achieves restoration more quickly than Alternative 3. Considering the diversity of habitat, Alternative 3 is again unsatisfactory as it does not allow for the creation of seasonal wetlands and limits the amount of upland habitat and high tide refugia that can be created. Alternative 2 provides the greatest diversity of habitat. Because Alternative 2 provides a greater quantity of habitat than Alternative 1, provides this habitat more quickly than Alternative 3 and provides a greater diversity than either Alternative 1 or 3, Alternative 2 best meets this study objective.

Table 4-12
Relative Rankings of the Study Alternatives
by Study Objectives and Evaluation Criteria

Objective or criterion	**Alternatives**		
	1	***2***	***3***
Wetland Restoration			
Endangered species	1	1	3
Creation of habitat value	2	1	3
Beneficial Reuse of Dredged Material			
Upland dredged material disposal capacity	1	2	3
Other considerations			
Economic efficiency- wetland	3	2	1
Economic efficiency- dredged material	2	1	N/A
Acceptability	1	1	3

Endangered Species Habitat
Although Alternative 3 would eventually provide a greater quantity of endangered species habitat, Alternatives 1 and 2 would provide substantial amounts of endangered species habitat more quickly than under Alternative 3. The two endangered species of particular concern here, the California clapper rail and the salt marsh harvest mouse, only occur around the San Francisco Estuary. These species have lost the vast majority of their habitat, and the clapper rail in particular is close to extinction. Provision of additional habitat for these species is considered to be very important by the resource agencies. Considerably accelerating the creation of this additional habitat would be a major benefit of Alternatives 1 and 2. Alternative 1 and Alternative 2 would provide more endangered species habitat value and therefore best meet this study objective.

Beneficial Reuse of Dredged Material
Using dredged material to accelerate the creation of habitat is a more costly method of producing wetland habitat units than natural sedimentation. Alternatives 1 and 2, which would use dredged material, would cost far more than Alternative 3, which would use only natural sedimentation. However, Alternatives 1 and 2 would alleviate the public concern regarding the environmental impacts of disposing of dredged material in an aquatic environment. Although Alternative 1 would beneficially utilize slightly more dredged material, Alternative 2 is provides slightly greater efficiency in dredged material placement, and so best meets this study objective.

Replacement of Seasonal Wetlands Alternative 1 does not provide any in-kind replacement of seasonal wetlands, Alternative 3 provides limited in-kind replacement, and Alternative 2 provides the highest level of in-kind replacement of the seasonal wetlands. Considering this factor, Alternative 2 performs more favorably than Alternatives 1 or 3.

Summary
Alternative 2 was selected because it provides the greatest diversity of habitat, allows for most efficient beneficial reuse of dredged material, provides critical endangered species habitat in the shortest amount of time, replaces the greatest amount of seasonal wetland and allows the greatest

degree of operational flexibility. Given all these considerations, Alternative 2 best addresses the study objectives of ecosystem restoration and beneficial reuse of dredged material. Alternative 2 also best addresses the other evaluation criteria of completeness, effectiveness, efficiency, and acceptability, while minimizing ongoing management. Therefore, it is selected as the tentatively recommended plan.